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Description of the antipredatory head-wobble behaviour in Chilean rear-fanged snakes *Tachymenis peruviana* Wiegmann, 1835 and *Tachymenis chilensis coronellina* Werner, 1898 (Serpentes, Dipsadidae)

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Abstract

In this work, we describe the first records of head-wobble behaviour for *Tachymenis peruviana* and *T. chilensis coronellina*. We analyse this behaviour (occurrence, frequency) and accompanying displays in both species. Of particular note is that *T. ch. coronellina* exhibited more frequent head-wobbling than *T. peruviana* and, in both records, wind activity was observed during this antipredatory behaviour.

Key Words

antipredatory behaviour, behavioural camouflage, Chile, colubrid snakes, Peru

Snakes exhibit a wide repertory of antipredatory behaviours including fast and secretive movements, cryptic camouflage, aposematic displays, mimicry and death feigning (e.g., Mutoh 1983; Herzog and Burghardt 1986; Gerald 2008; Gregory 2008, 2016; Santos et al. 2018; Zañartu and Urra 2020; Davis et al. 2021). Notably, head-wobble is a poorly reported behaviour exhibited by some rear-fanged snakes, which involves an oscillating movement of the head and neck while the rest of the body remains motionless (Ryerson 2017). This behaviour has been described in *Tantilla melanocephala* (Linnaeus, 1758) in Venezuela (Sánchez-Guillen and Mendoza-Mendoza 2014), and *Thamnophis sirtalis* (Linnaeus, 1758), *T. sauritus* (Linnaeus, 1766), and *Opheodrys vernalis* (Harlan, 1827) in New Hampshire, USA (Ryerson 2017). Apparently, head-wobble might be a behavioural camouflage that allows the snake to maintain, with some precision, a match between its movements and the pattern of movement of the grass in windy conditions (Ryerson 2017). Until now, it has not been known if other Neotropical rear-fanged snakes perform head-wobble, and if this behaviour is accompanied by others displays, like an exploration of chemical stimuli under a predatory context.

The *Tachymenis* genus is composed of six species of small rear-fanged snakes distributed in Argentina, Bolivia, Chile, and Peru (Walker 1945; Donoso-Barros 1966; Valenzuela-Dellarossa et al. 2010). These species have viviparous

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reproduction (Urra et al. 2021), cathemeral habits (Vellard 1955; Contreras et al. 2019; Zañartu and Urra 2021) and prey on anurans, lizards, and fishes (Baudoin and Pacheco 1991; Greene and Jaksic 1992; Miranda et al. 2015; Paredes et al. 2016). Of all of them, the natural history of *T. peruviana* and *T. chilensis* (which has currently recognised two subspecies, i.e. *T. ch. coronellina* and *T. ch. chilensis*) is probably the best known; however, several aspects of antipredatory behaviour remain uncertain. Under a threat or potential predator´s attack, both species display an antipredator behaviour, involving jumps with bite attempts and the exhibition of the open mouth (Donoso-Barros 1966; Demangel 2016). Moreover, balling behaviour, which involves rolling the body with the head hidden, forming a sphere (Mitchell 1978), has been described for a juvenile specimen of *T. chilensis* (Donoso-Barros 1969). These complex repertories have been reported from anecdotal observations, lacking formal recording. In this work, we described the first reports of head-wobble for *T. peruviana* and *T. ch. coronellina*.

One videotape of an individual of *T. peruviana* performing head-wobble (Suppl. material 1: Video S1), and two for an individual of *T. ch. coronellina* (Suppl. materials 2,3: Videos S2, S3, respectively), were recorded at approximately 15 cm from the individuals using a cell phone (Samsung GalaxyS7, Samsung Mobile, Seoul, South Korea) and a photographic camera (Canon PowerShot SX60 HS, Canon, Ōta, Tokyo), respectively. From videotapes and using a behaviour analysis software (BORIS; Friard and Gamba 2016), we scored five displays: 1. head-wobble (occurrence and frequency, Hz), 2. tongue flicks (occurrence), and the total time (seconds, s) that they, 3. rest, 4. moved, and 5. moved the head and the front part of the body backwards (thereafter 'Head backward'). The behaviours of video 3 were measured until the snake could not be seen because it hid in a shelter (Suppl. material: Video S3). All videotapes can be accessed at https://doi.org/10.34691/FK2/VSB4D4.

On December 15, 2015, at 11:40 h, during a field trip carried out in Quebrada Ramucho, Tarapacá Region, Chile (21°04'S, 68°51'W; 3890 m elevation), we found an individual of *T. peruviana* that was hiding among the vegetation of a marsh. After one minute, and when an observer approached the snake, it began to perform head-wobble, i.e., it moved its head and neck simultaneously from side-to-side, while the rest of its body was motionless (Suppl. material 1: Video S1). This behaviour was interrupted by periods when no head-wobble was performed and was accompanied by tongue flicks (Fig. 1A). When the observer got closer (~ 15 cm), it stopped making head-wobble and performed head backward (Fig. 1A), until it escaped by hiding in the vegetation. Remarkably, a moderate wind blew throughout this behavioural record (Suppl. material 1: Video S1).

On April 4, 2019, at 16:20 h, during a field trip carried out in El Panul, Coquimbo Region, Chile (30°00'S, 71°23'W; 94 m elevation), we found under a stone shelter a motionless specimen of *T. ch. coronellina* that subsequently displayed two periods of head-wobble (Suppl. material 2, 3: Video S2, S3). The first head-wobble period (Suppl. material 2: Video 2; Table 1) began one minute after the snake was found and when the observer approached about 30 cm from the snake's head. The snake simultaneously did a head-wobble and tilted its head backward, displaying them at rest. For 15 s, it did tongue-flick the air until it became motionless (Fig. 1B). Subsequently, a second head-wobble period (Suppl. material 3: Video S3; Table 1) with increased amplitude in the oscillatory movement of the head was observed. This was performed while the snake displayed tongue flicks to the air and displaced slowly towards a nearby stone shelter (Fig. 1C). This period ended when the snake could no longer be observed under the shelter (Suppl. material 3: Video S3). The occurrence and frequency of head-wobble displays had greater duration in the second than in the first period, and both exceeded what was observed for *T. peruviana* specimen (Table 1). As with this latter species, the wind always blew intensely during the head-wobble displays of *T. ch. coronellina* (Suppl. material 3: Video S3).

Table 1. Occurrence, frequency, and inter-event intervals of the head-wobble behaviour displayed by each individual specimen of *Tachymenis peruviana* (videotape file 1) and *T. chilensis coronellina* (videotapes 2 and 3). *The data are shown as mean ± standard deviation (SD).

Species	Video file	Total video time (s)	Occurrence	Frequency (Hz)	Inter-event intervals (s)*
Tachymenis peruviana	1	29	14	0.48	0.81 ± 0.84
Tachymenis chilensis coronellina	2	34	38	1.1	0.53 ± 0.54
	3	73	159	2.2	0.42 ± 0.41

Although the high wind activity and early ontogenetic stages apparently correlate with the head-wobble behaviour in rear-fanged snakes (Sánchez-Guillén and Mendoza-Mendoza 2014; Ryerson 2017), the factors that drive this antipredatory strategy are scarcely understood.

In this work, we described the first reports of head-wobble behaviour, which were accompanied by others displays, for two adult specimens of *T. peruviana* and *T. ch. coronellina* from Chile. Consistent with previous observations (Sánchez-Guillén and Mendoza-Mendoza 2014; Ryerson 2017), the head-wobble behaviours were performed in response to humans approaching under conditions of a moderate wind. In both specimens, the head-wobble was performed when the rest of the body was motionless and was accompanied by repeated tongue flicks. *T. ch. coronellina* exhibited head-wobble with more frequency than *T. peruviana* (Table 1) and was the only one that performed this while it was moving or deploying head-backward, joint displays that had not been described for other snake species (Sánchez-Guillén and Mendoza-Mendoza 2014; Ryerson 2017).

Although *Tachymenis* species exhibit a known defensive behaviour to human approaching and handling, attempting to bite (Donoso-Barros 1966), with occasional human envenomation (Gajardo-Tobar 1947, 1958; Vellard 1955), this active behaviour of defence was not observed during our records of head-wobbling.

Since the natural history and antipredatory behaviours of *Tachymenis* snakes are poorly known, our report of the head-wobble behaviour in *T. peruviana* and *T. ch. coronellina* highlights the need for more studies on the ethology of these species.

Figure 1. Graphical representation of the behaviours recorded for **A.** *Tachymenis peruviana* and **B, C.** *T. chilensis coronellina*, which correspond to videotapes 1, 2 and 3, respectively. The head wobble and tongue-flick behaviours were measured as occurrence or the number of times, and the head backward, rest and displacement, as the total time that snakes exhibited these behaviours at videotapes, which can be accessed at https://doi.org/10.34691/FK2/VSB4D4.

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Supplementary material 1

Video S1

Authors: Claudio Reyes-Olivares, Alex Vera-Quispe, Alejandro Zúñiga, Félix A. Urra

Data type: Video file

Explanation note: *Tachymenis peruviana*.

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Supplementary material 2

Video S2

Authors: Claudio Reyes-Olivares, Alex Vera-Quispe, Alejandro Zúñiga, Félix A. Urra

Data type: Video file

Explanation note: *Tachymenis chilensis coronellina*, first record

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Supplementary material 3

Video S3

Authors: Claudio Reyes-Olivares, Alex Vera-Quispe, Alejandro Zúñiga, Félix A. Urra

Data type: Video file

Explanation note: *Tachymenis chilensis coronellina*, second record.

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